V.A.2 DTE Energy Hydrogen Technology Park

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Objectives

Discover and document whether the power park concept is technically and economically viable as a clean energy system, and if so, under what operating and market conditions. Specific objectives include:

- Develop and test a hydrogen co-production facility having stationary fuel cell power and vehicle fueling capability using renewable and non-renewable resources
- Employ representative commercial units under real-world operating conditions
- Based on performance data, project experiences, and market assessments, evaluate the technical and economic viability of the power park system
- Contribute to development of relevant safety standards and codes required for commercialization of hydrogen-based energy systems
- Identify system optimization and cost reduction opportunities including design footprint, co-production, and peak-shaving applications
- Increase public awareness and acceptance of hydrogen-based energy systems

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- C. Hydrogen Refueling Infrastructure
- E. Codes and Standards
- H. Hydrogen from Renewable Resources
- I. Hydrogen and Electricity Co-production

Approach

- Design, install, and operate an integrated hydrogen co-production facility featuring electrolytic hydrogen production, on-site gas storage, stationary fuel cell power generation, vehicle dispensing, on-site renewable solar energy and biomass energy (using grid connection as necessary).
- Collect, analyze, and report system performance data and lessons learned for an integrated co-production facility operating under real-world conditions.
- Evaluate opportunities to reduce system costs and optimize performance through methods like peak shaving and the integration of power and transportation applications into a common infrastructure.
- Evaluate commercialization opportunities for an advanced power park facility.

Accomplishments

- Established and implemented project safety plan
- Completed site plan and system design
- Specified and procured all major equipment
- Obtained all required permits from authorities having jurisdiction
- Held project groundbreaking event
- Installed & commissioned system – 10% complete
- Developed data collection & analysis plan – 25% complete
- Developed education & outreach program – 20% complete
- Participated in Michigan Department of Environmental Quality ad hoc committee on hydrogen codes & standards
- Selected to participate in the DOE's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Future Directions

- Complete system installation & commissioning
- Complete data collection & analysis plan
- Complete education & outreach program
- Operate, monitor, and maintain system
- Develop project technical report
- Assess economics & develop business plan, as appropriate
- Document and publish project results
- Integrate site into Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project (FY 2005-FY 2008)

Introduction

Given the potential for the commercialization of hydrogen as a carrier for energy to replace fossil fuels, this demonstration project, which models an end-to-end renewable hydrogen energy system, is intended to provide meaningful information into the technical and economic challenges of realizing a hydrogen-based economy.

This project develops, installs, and operates a hydrogen co-production facility capable of delivering 500 kWh/day of on-site electricity and 15 kg/day of compressed hydrogen for vehicle refueling (Figure 1). By incorporating the most commercially representative units into a complete system operating under real world conditions, this approach is designed to validate system and component technical targets and provide feedback to the Department of Energy as to the commercial viability of hydrogen energy systems.

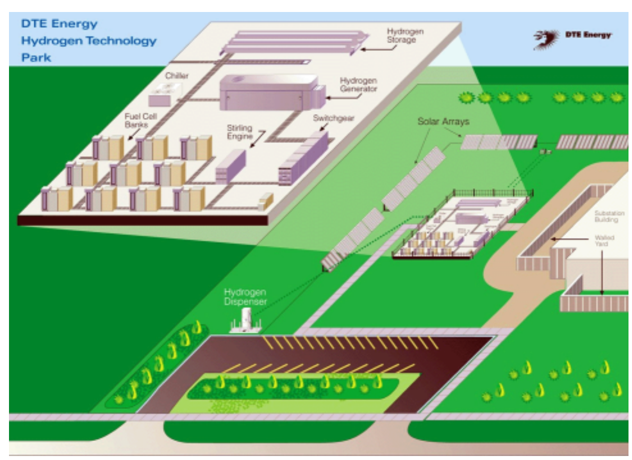

Figure 1. DTE Energy Hydrogen Technology Park, Southfield, MI

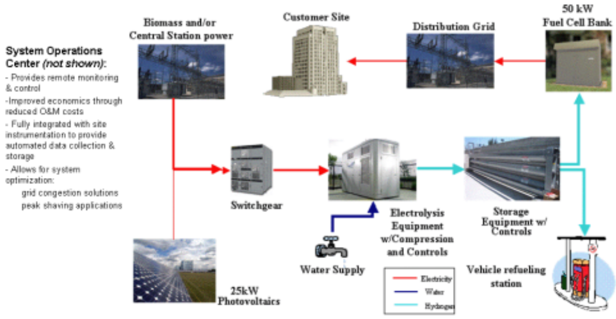

Figure 2. Process Flow Diagram

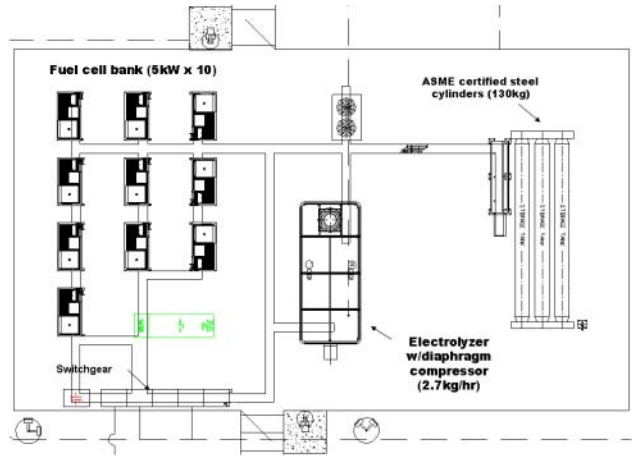

Figure 3. Equipment Pad Layout

Approach

The project takes advantage of power during off-peak hours to generate hydrogen for on-peak power generation and vehicle fueling (see Figure 2). The facility uses a blend of renewable and non-renewable power to generate the hydrogen from regular tap water. The hydrogen is then compressed and stored for later use. During peak hours, the stored hydrogen is used to operate a 50 kW bank of stationary fuels cells, designed to provide on-site power for a future building or load. In addition, the stored hydrogen is available in sufficient capacity to dispense 15 kg/day at 5000 psi or enough for approximately three (3) fuel cell vehicles per day.

The integrated system approach provides opportunities to reduce costs and optimize performance, including the integration of power generation and transportation applications onto a common infrastructure. The system is designed for remote control and monitoring, which provides a number of operating advantages, including reduction of required on-site personnel, pre-programmed operations, and automated data collection.

Results

Since the FY 2003 report, a number of important project development and system implementation milestones have been accomplished. The integrated site plan was completed, submitted to the City of Southfield, and approved. As part of the site plan approval process, a number of topics were addressed and successfully resolved, including proposed site use, potential impacts to adjacent businesses, neighborhoods, traffic flows, and rain water drainage of the grounds given new parking lot and equipment pad surface areas.

Following site plan approval, full system design was completed and approved. Figure 3 shows the details of the equipment pad including the layout of the fuel cells, electrolyzer, storage cylinders, and switchgear. Considerable work was done to make the combination of commercial and pre-commercial equipment interface properly and safely in an integrated system. For example, because the fuel cell power generation system is a first of its kind and pre-commercial, significant system engineering was required to develop ten compact fuel cell-battery-inverter subsystems that properly interface to produce the required AC power. Also, a condensed equipment pad was developed despite having to increase the size of our storage cylinders when changing from the original composite tanks to ASME compliant steel cylinders.

System design also included development of an integrated control and safety system (Figure 4). The system is capable of: 1) remotely monitoring and recording all relevant system parameters including equipment runtimes, power consumption, hydrogen mass produced and consumed, component and system efficiencies, and alarms and warnings; 2) remotely starting and stopping individual system components; and 3) initiating automatic emergency shutdowns should certain system conditions be reached.

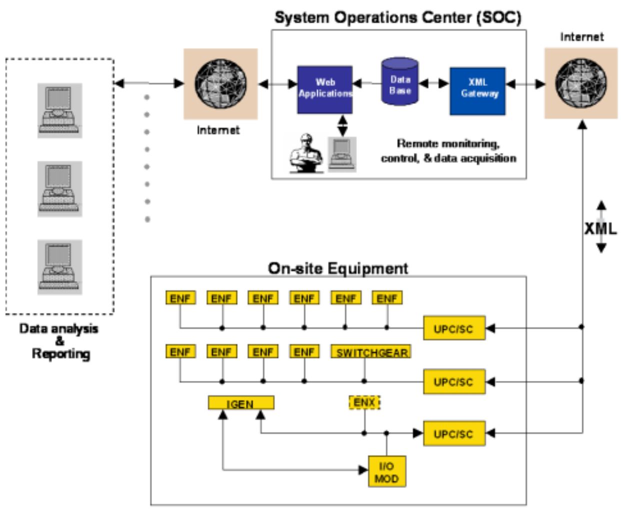

Figure 4. Remote Monitoring & Control System

Another major accomplishment was the specification and procurement of all major equipment for the facility. This included the switchgear, electrolyzer, compressor, storage vessels, gas control panel, fuel cell power generation system, vehicle re-fueling dispenser, remote monitoring and control system, system instrumentation, and the site security system. Considerable effort was required to specify the hydrogen dispenser, given that there is no one hydrogen-fueling protocol for vehicles that is universally accepted by equipment makers and OEMs. Following detailed discussions with industry partners and equipment suppliers, the team settled on the California Fuel Cell Partnership's Fueling Protocol revision 6.1, which garnered the greatest consensus of the parties involved.

Once system design and equipment specifications were complete, a system installation specification was developed and selection of a contractor to construct the facility made. Crews have now been mobilized and construction begun.

From discussions with the State of Michigan's Department of Environmental Quality, it was determined that no state permits were required for the planned facility. However, the State was interested in reviewing the project plans for informational purposes and has requested our participation in an ad hoc committee formed to develop hydrogen storage certification and licensing standards for the State of Michigan.

With the establishment of BP America as a primary project partner, the project underwent a complete safety and design review in order to validate the programs and practices that were in place. This included a hazard identification workshop, where all significant system and component hazards were identified and specified. There were no significant issues or safety concerns identified by this investigation.

Conclusions

Considerable progress has been made implementing the project and achieving project milestones. In particular, site plan approval, system design, equipment procurement, permitting, safety reviews, and the start of construction have all been accomplished since the FY 2003 report. Because of funding delays at both the state and federal levels, the project is approximately six months behind the originally proposed schedule. Those delays have had a considerable impact on the project and its partners. For example, a shortage of steel that developed in 2004 resulted in the unavailability of the originally specified storage vessels. In addition, construction costs have increased 30-40% from original estimates as the cost of materials has increased significantly.

Key activities currently underway include installation & commissioning of the system, development of an education and outreach program, and development of a data collection and analysis plan. Once system installation and commissioning are complete, the project will enter Phase III, which will involve operating, monitoring, and maintaining the system; data collection & analysis; continued education and public outreach; and developing the project reports.

Finally, with the integration of this project into the DOE's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project (FY 2005-FY 2008), the duration and scope of the Hydrogen Technology Park will have been increased. This significantly improves the opportunities to assess the value that these systems create and to evaluate the various pathways available for commercializing hydrogen as a viable alternative energy carrier.

FY 2004 Presentations

1. R. Regan, "DTE Energy Hydrogen Technology Park," MicroGeneration to PowerParks Conference, Lansing, MI (November 2003).

2. R. Regan, "DTE Energy Hydrogen Technology Park," 2004 DOE Program Review, Philadelphia, PA (May 2004).